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INDIVIDUAL DIFFERENCES IN REACTIONS TO IRREGULAR WORK HOURS

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Introduction

Irregular work hours cause disturbed sleep, reduced alertness and an increased risk of errors and accidents (Åkerstedt, 1998). The reasons are mainly the circadian system which increases metabolism during daytime and reduces it during night time, thus laying the foundation for effective performance during daytime, but also causing poor sleep during that period (Åkerstedt, 1995). During the night time the circadian nadir instead promotes sleep and causes reduced alertness and performance in the night working individual. The night time effects are also strongly enhanced by the increased time awake preceding the night work period.

However, the effects of irregular work hours clearly differ between individuals - some will have major problems whereas others may thrive on it (Härmä, 1993). Clearly, there is a practical and theoretical interest in trying to understand which individual factors may be of importance in this respect. The present paper will look at some of those factors.

Before starting, however, it should be pointed out that authors have taken very different attitudes to the dependent variable. Thus, outright disease, attitude to work hours, fatigue, sleep disturbance, accidents and performance failure have been used. This has probably contributed to some of the confusion in the area. The variables that have received most attention over the years are age, gender, experience, diurnal type, sleep flexibility, circadian amplitude, and neuroticism. None of them have proved very successful, however, and there might be alternatives. First, lets look at a methodological problem and then discuss the traditional factors.

Most of the studies in this area have been carried out with cross-sectional approaches. Thus, it is very easy to fall prey to circular reasoning. For example if one asks shift works if they have any problems displacing sleep and then asks them what their sleep is like on different shifts, it would be very surprising indeed if one did not find that sleep flexibility is a good "predictor" of sleep disturbances and other problems in shift workers. We run the same risk with neuroticism (it my easily be a consequence of shift work rather than the reverse).

Traditional factors of doubtful value

Neuroticism

One of the most well researched factors is neuroticism. A number of studies have shown consistent high relations with problems in shift work (Parkes, 1994; Iskra-Golec et. al., 1995; Taylor et. al., 1997) On the other hand, one of the few prospective studies show no such relation (Kaliterna et. al., 1995). Obviously, one may suspect that neuroticism may be a consequence of shift work, rather than the reverse (Bohle and Tilley, 1989). This is the prevailing opinion among researchers in this area.

Sleep flexibility

Rigidity of sleep patterns, i.e. feeling unable to move sleep to other times of day than the

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conventional night hours (Folkard et. al., 1979; Costa et. al., 1989), is another dimension that has been used to predict adjustment to shift work in general although little data seem available on its application to alertness patterns specifically. Wynn et al (1986), however found that rigidity predicted general fatigue and sleep difficulties in nurses changing to an alternating day/night work period. However, two prospective studies have failed to find any predictive power. (Vidacek et. al., 1987; Kaliterna et. al., 1995). The results indicate that sleep flexibility is not a factor in tolerance of shift work.

Circadian amplitude

Several studies have tested the hypothesis that the circadian amplitude (usually of the body temperature rhythm) should be related to difficulties in shift work (Reinberg et. al., 1978; Reinberg et. al., 1984). The rational has been that a large amplitude should be more difficult to adjust to phase shifts of work and sleep .However, this does not appear to be the case, most of the amplitude differences between individuals seem to be effects of masking by shift work (Minors and Waterhouse, 1983; Vidacek et. al., 1987).

Gender

Studies of males and females seem to suggest that women should have slightly more problems in shift work, particularly with respect to fatigue and injuries (Novak et. al., 1990; Dirkx, 1991, Oginska, 1993 #2525). And women seem to a slightly larger need for sleep (Wever, 1979). On the other hand, studies which control for responsibility for small children find no differences (Estryn-Behar et. al., 1978, Beermann, 1995 #3401; Estryn-Behar et. al., 1990). And indeed, lab studies of night work show no differences between men and women (Hakola et. al., 1996) . The conclusion seems to be that there is no difference in shift work tolerance between men and women if social responsibility is controlled for.

Traditional factors of possible value

Age

Thus, one might expect age to have a negative influences on sleepiness. This is not necessarily always the case, however, rather the reverse. Several studies suggest that older individuals suffer less from night shift sleepiness than young (Fröberg et. al., 1972; Bonnet and Rosa, 1987; Monk et. al., 1992) . It seems, however, that several night shifts in a row raises sleepiness more in older workers (Härmä, 1995).

With respect to disturbed sleep, there is usually seen an increase with increasing age and experience (Foret et. al., 1981; Åkerstedt and Torsvall, 1981a; Parkes, 1994). In EEG studies we have found trends towards more superficial sleep in middle-aged shift workers (Torsvall et. al., 1981). On the other hand older individuals usually have less problems in relation to early morning work. We have not, however, found any relation between age and sleepiness, except for the fact that accident rates on the road seem to be lower at night in older individuals.

Experience of night work

The two previous studies (Foret et. al., 1981; Åkerstedt and Torsvall, 1981a) also indicated that experience was negatively related to general wellbeing over a number of years. Koller et al (1983) found that reduced health appeared earlier in shift workers than in day workers. Dahlgren (1981) found no effects of three years of night work on the rhythm of rated activation across night shifts. Neither did Wynn (1986) over a temporary 10-week period of weekly alternation between night and day work in a group of nurses. Dumont (1987) found that the amount of sleep/wake and related disturbances in present-day workers were positively related to their previous experience of night work. Guilleminault et al (1982) found an overrepresentation of former shift workers with different clinical sleep/wake disturbances appearing at a sleep clinic.

Neither Folkard et al (1978) nor Knauth et al (1981) observed any such "long-term" adjustment. Van Loon (1963) did claim that one of his three subjects increased his speed of adjustment and Dahlgren (1981) did find that after 3 years of rotating shiftwork the flattening occurred earlier in the week. It is not clear, however, whether this was due to a permanent adjustment, i.e. one that included days off. The data cited, together with the increased subjective nightshift difficulties which have been found to be associated with increasing age and experience (Foret et. al., 1981; Torsvall et. al., 1981; Åkerstedt and Torsvall, 1981a) do not speak strongly for experience as a major factor in adjustment. The issue, however, can only be answered definitely through a longitudinal study.

In relation to shift work there is some indication that morningness is associated with poor adjustment to shift work (Aanonsen, 1964; Folkard et. al., 1979; Åkerstedt and Torsvall, 1981b). Breithaupt (1978) and Härmä (1995) failed to find such a relation and prospective studies (Kaliterna et. al., 1993; Vidacek et. al., 1993; Kaliterna et. al., 1995) found no predictive power. Frequently it is found that morningness and age are highly correlated and that the any "effects" of diurnal type may rather be effects of age. An additional observation is that there is a selection into shift work of evening types (Knutsson and Åkerstedt, 1992). We also found in an early study that three-shift workers who were transferred to day work (for organizational/economical reasons) change their diurnal type strongly towards morningness (Torsvall and Åkerstedt, 1980).

Physical condition

Possibly, also the physical condition of the individual might be of importance to night shift sleepiness. Thus Härme et al (1986) had three-shift workers improve their physical fitness through a training program. This greatly reduced rated overall fatigue as well as increased two-hourly ratings of alertness on the night shift. Another factor that will exacerbate night work sleepiness is sleep pathology such as that associated with, for example, sleep apnea (Lavie, 1981)

Some alternative possibilities

As indicated above there are available very few experimental or prospective studies that may shed light on the inter-individual differences in tolerance of night work. However, we have conducted several studies that may be of some interest in this context.

Individual differences in tolerance in rapidly rotating shift work

One approach to inter-individual differences in tolerance may be to compare tolerants and non-tolerants on a number of trait and state variables. We used this approach in a 400 rapidly rotating shift workers at a paper mill (Åkerstedt, unpublished data). The schedule involved a Night shift (2200h-0600h) - 8 hours off - an Afternoon shift (1400h-2200h) - 8 hours off - a Morning shift (0600h-1400h) - 56 hours off (i.e. 2 normal night sleeps). Then the cycle repeated again six more times, after which followed a week off.

From the total population was selected a group of 60 subjects who scored 1 or 2 (very negative + negative) and 4 or 5 (positive + very positive) on the scale describing their attitude to their work hours. Half the subjects in each group were women. The four resulting groups were also followed with actigraphy, sleep diaries and daily alertness logs during triad 1, 3 and 5. The results were analyzed using a two-factor ANOVA with gender and attitude as factors.

The results showed that among the factors that did not differentiate between the attitude groups or showed an interaction, were age, BMI (significant effect for gender), marriage status, number of children, or diurnal type. However the non-tolerants reported significantly more sleepiness, less "sufficient sleep", less feeling well restide, a higher need for sleep (8.31±.31h vs 7.15±.21 for men and 8.83±.47 vs 8.23±.31h for women) - note that women reported a significantly

higher need for sleep. In addition, testosterone levels were lower in non-tolerants (9.4±.9 vs 13.5±.1 nmol/L), whereas prolactine and cortisol did not differ. Three more variables became highly significant and were the ones entering the final step of the stepwise multiple regression analysis (in which all previous variables were tested) against attitude. This were Mean Sleepiness during the afternoon shift (R2=.37, beta=-.62), Sufficient time for family (R2=.17, beta=.57) and Sleep quality before the night shift (R2=.09, beta=.48). Note that the sleepiness on the afternoon shift would be high if sleep after the night shift was unsuccessful. The results clearly suggest that the important factor behind the attitude were related to sleep and sleepiness in relation to the displaced work hours, and to the social consequences.

Differences in tolerance of long shifts

In another study we tried to find what was related to tolerance of a schedule which required seven 12h shifts (0700-1900h) followed by a week off (Åkerstedt, unpublished data) Here we selected one extreme group (12 workers) who reported no fatigue during the working week and another who reported fatigue, although rather moderate. Both groups were strongly in favor of their schedule because of the week off. The same measurements were used as in the previous study.

The results showed that the fatigued group reported lower sleep quality and shorter sleep (5.4±.2 vs 6.0±.2h), longer time awake, higher sleepiness during the working week. During the recovery week they slept longer (8.9±.3 vs 7.9±.3). They were also more morning oriented and younger.

When these variables were tried in a stepwise multiple regression analysis against fatigue it was found that the only significant predictor became "Well rested" (R2=.34, beta=-.58). To study the dynamics this variable was removed and the new significant predictor became "Sufficient sleep" (R2=.33, beta=-.58). When this variable was removed age (low) became the significant predictor (R=.17, beta=.41), and when age was removed, both diurnal type (evening) and need for sleep (high) became significant (R=.17, beta=.42 and R2=.17, beta=-.41). TST, Sleep efficiency, Sleep quality, Ease of rising, Number of small children, etc remained outside of the regression. The results suggest, again, that sleep and alertness are key factors, but here it also seems that some of role of sleep and alertness is related to age, diurnal type, and need for sleep. Note that the group studied were day workers who had to rise from sleep around 6 a.m. This may have brought in diurnal type and age.

Conclusion

This limited review suggests that some traditional factors like, personality and circadian amplitude seem to have little to do with tolerance of shift work. Neither does gender, at least not if social responsibility is controlled for. Age on the other hand seems of more interest and also diurnal type, but the two seem closely related.

However, the major determinants of shift work tolerance probably have more to do with states or rather ways of coping with irregular work hours. Thus, the way an individual organizes his behavior to promote sleep may be of importance, as may be the need for sleep. This may be related to commitment to night work, avoiding light after night work, etc. One should probably give priority to teaching sleep/wake optimization, rather than trying to find individuals with particular traits. One gets the feeling that the highly tolerant single night shift worker would be older, have a low need for sleep, have a high sleep quality, be in good physical shape, and plan sleep strategically (using naps). If several night shifts occur in sequence, younger individuals may have an advantage.

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